Bull. Natn. Sci. Mus., Tokyo, Ser. A, 18 (4), pp. 167–174, December 22, 1992

A New Species of Fossil Beaked Whale, *Mesoplodon tumidirostris* sp. nov. (Cetacea, Ziphiidae) from the Central North Pacific

By

Nobuyuki MIYAZAKI

Department of Zoology, National Science Museum, Tokyo

and

Yoshikazu HASEGAWA

Geological Institute of Yokohama National University, Yokohama

Abstract A new species of fossil beaked whale, the genus *Mesoplodon* (Cetacea, Ziphiidae), was discovered at a depth of 720 m on the sea bottom between the Emperor Seamounts and Midway Island off Hawaii, and was described from rostral fragments. The rostrum had about 20 small and shallow alveoli, and a large inflated mesorostral ossification on the dorsal surface from the posterior part of rostrum to the anterior of nares. Intraspecific variation was discussed.

Fossil beaked whales appear in the lower Miocene and are well represented by upper Miocene (KELLOGG, 1928; MEAD, 1989). Because most material of fossil ziphiids are the remnants of rostra and complete preserved specimens are lacking, it is very difficult to identify the species. This is one of two major problems with studies on evolution of the beaked whales. The second is that the living ziphiid species, which habit in the pelagic waters, show a wide variation of cranial characters with age and sex (FRASER, 1942; MITCHELL & HOUCK, 1967; OMURA, 1972).

The living beaked whales comprise 19 species in 5 genera (*Mesoplodon*, *Tasmacetus*, *Berardius*, *Ziphius and Hyperoodon*) in the family Ziphiidae (IUCN, 1988; MEAD, 1989; REYES *et al.* 1991). This family is characterized by elongation of the rostrum, reduction of the dentition and elevation of the narial region. Of the 5 genera, the genus *Mesoplodon*, with 13 species (68% of the total), is the most important for considering specific diversity in the family Ziphiidae. The skull in *Mesoplodon* species is characterized by the extreme development of cranial vertex, involving the postero-dorsal extensions of the maxillary, premaxillary, frontal, supra-occipital, and nasal bones. The ventral surface of the skull shows enlargement of the pterygoids and enormous development of pterygoid sinuses. In the North Pacific, the following five living species have been recognized: *M. carlhubbsi*, *M. densirostris*, *M. ginkgodens*, *M. hectori and M. stejnegeri* (MOORE, 1963; MIYAZAKI *et al.*, 1987). *M. stejnegeri* is found in cold temperate and subarctic waters while the other four species are

distributed in temperate and subtropical waters.

The present study was undertaken to describe characters of rostral fragments of two fossil beaked whales from the central Pacific Ocean and to report a new species of the genus *Mesoplodon* GERVAIS, 1850.

Materials and Methods

Two fossil beaked whales were obtained from the sea floor in 720 m by a trawl net in early September 1990. This area is located between the Emperor Seamounts and Midway Island off Hawaii (32°36'N, 172°26'E). NAKAMURA (1989) showed a good linear relationship between the distance from Mountain Kilauea to the areas on the Hawaiian-Emperor Seamounts and the geological age of the area estimated by the relationship of radioisotope kalium and argon. Based on this K-Ar dating method, it was estimated that the sea bottom where the specimens were collected might be aged from about 40 million years ago. Precise information on the collection locality for the present specimens was not available and geological samples were not obtained for estimation of age.

These specimens were collected by Mr. Yūzo MIKUNI and had been preserved in the house of Mr. Misao IWABUCHI, father-in-law of Mr. Y. MIKUNI. In order to identify the fragments, Mr. M. IWABUCHI, owner of the specimens, brought them to Mr. Jun-ichi YAMASHIRO, a staff member of the Kushiro City Museum in Hokkaido, Japan, who then sent them to the senior author for study. The two fossil specimens (specimen nos. NSM-PV 19732 and NSM-PV 19733) are deposited in the Division of Paleontology of the National Science Museum, Tokyo, Japan.

Description of a New Species

Family Ziphiidae

Genus ***Mesoplodon*** GERVAIS, 1850

Mesoplodon tumidirostris sp. nov.

[New English name: large-mesorostral beaked whale]
[New Japanese name: Kobu-oogihakujira]

(Figs. 1–8)

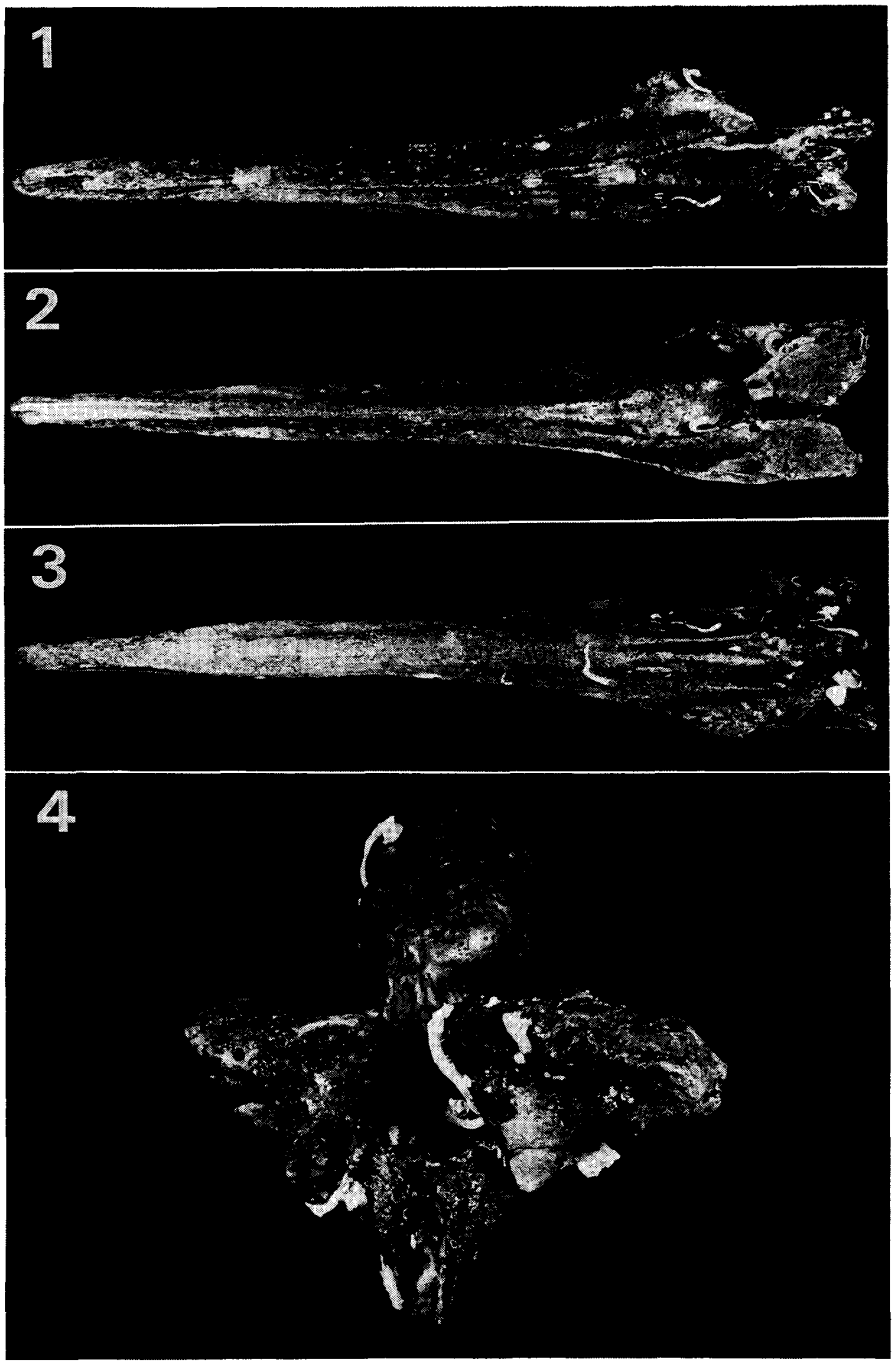
Holotype: One rostral fragment 559 mm long (NSM-PV 19732), 32°36′N, 172° 26′E, 720 m depth. Paratype: One rostral fragment 405 mm long (NSM-PV 19733), 32°36′N, 172°26′E, 720 m depth.

The description of the above two specimens of the beaked whale is based on rostral fragment characters, measurements of which are given in Table 1. These specimens contain the greater portions of maxillae, premaxillae and vomer. They are heavy and dense, as are typical of both fossil and living ziphiid rostra. The rostrum is dark brown with a few shallow holes. The shape of the mesorostral

ossification with a huge lump is characteristic of this species.

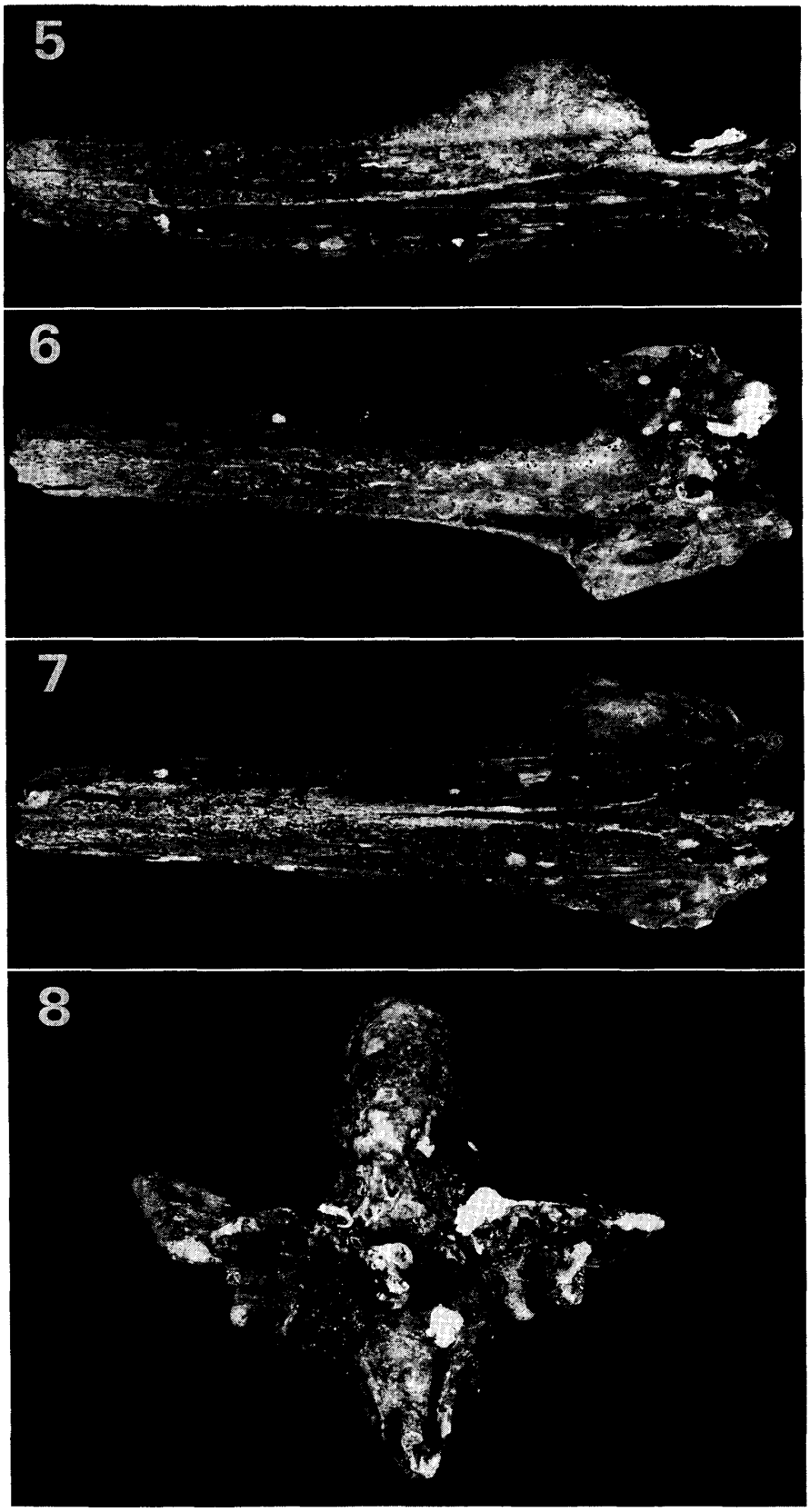
The holotype specimen consists of the rostrum and the ascending processes of the maxillae and premaxillae, broken from the rest of skull just anterior to the nares (Figs. 1–4). The overall length of the specimen is 559 mm and the greatest width is 113 mm. The great mesorostral ossification occupies the midline of the dorsal surface from the posterior part of rostrum to the anterior of nares, and is slightly curved to the right side at its posterior part. Although PILLERI and PILLERI (1982) used "supravomerine" as the technical term for "mesorostral ossification" where the cartilaginous septum above the vomer between the two premaxillae is ossified, we use the latter term in this study, following FRASER (1942). The anterior margin of the mesorostral ossification with a huge lump is 338 mm back from the rostrum tip. The lump is 144 mm in length, 48.2 mm in greatest width and 51.0 mm in maximum height. The length from the tip of rostrum to the end of vomer is 550 mm and the rostral length is 444 mm. Length of the right tooth row is 44.4% of the rostral length. The specimen has about 20 small and shallow alveoli of 3.4 mm maximum diameter in the right side and 8+ in the left. No teeth are present. The maxillary foramina are located on almost the same line as the premaxillary foramina. On the ventral surface, a pair of foramina are located back 285 mm from the tip of rostrum, where a groove runs forward from each foramen, and becomes shallower and disappears about 125 mm from the tip of the rostrum. Distance of both foramina is 23 mm. In the lateral view, the rostrum is slightly sigmoid, as is the suture between the maxilla and premaxilla. The rostrum is deepest near the posterior end, where the maxillae are embraced by the pterygoids. The tip of the rostrum is slightly eroded on both sides, but appears to keep its shape. The premaxillae are separate at this point, forming a terminal notch as seen in the living ziphiids. There is no clear separation between premaxillae and vomer. The premaxillae slope steeply dorsomedially throughout their length, embracing the mesorostral ossification. The air sinus outside the pterygoid on the posterolateral side of the maxilla is subtriangular with the apex forward and is 9.7 mm length. Ventral to this, at the posterior end of the rostrum, is the pterygoid impression.

The paratype specimen does not have a complete rostrum, the anterior part being broken (Figs. 5–8). The specimen is also heavy and dense, and has the remarkably large mesorostral ossification on the dorsal surface from the posterior part of the rostrum to the anterior of the nares. The ossification occupies the midline of the rostrum, and is 168 mm in length, 39.7 mm in greatest width and 49.0 mm in maximum height. The huge lump of the ossification is also posteriorly curved to the right side as in the holotype. The rostral width at the anterior end of the mesorostral ossification in this paratype specimen is larger than that in the holotype, whereas both rostral widths at the base are almost the same. The distance between the line connecting the posterior end of the right and left premaxillary foramina and that of the maxillary foramina is almost zero for the holotype, but for the paratype it is about 11 mm, the maxillary foramina being posterior to the premaxillary foramina.



Figs. 1–4. 1. Lateral view of the holotype of *Mesoplodon tumidirostris* sp. nov. (NSM-PV 19732). 2. Dorsal view of the same specimen. 3. Ventral view of the same specimen. 4. Posterior view of the same specimen.

Figs. 5–8. 5. Lateral view of the paratype of *Mesoplodon tumidirostris* sp. nov. (NSM-PV 19733). 6. Dorsal view of the same specimen. 7. Ventral view of the same specimen. 8. Posterior view of the same specimen.



Discussion

These two specimens are readily assignable to the family Ziphiidae on the basis of the reduction of maxillary dentition and prolongation of the rostrum. The fossil beaked whales have been assigned to the following 16 genera of the family Ziphiidae: *Belemnoziphius*, *Berardiopsis*, *Cetorhynchus*, *Choneziphius* *Diochotichus*, *Eboroziphius*, *Mesoplodon*, *Mioziphius*, *Palaeoziphius*, *Pelycorhamphus*, *Proroziphius*, *Ziphioides*, *Incacetus*, *Notocetus*, *Squalodelphis* and *Ziphirostrum* (KELLOGG, 1928, MEAD, 1975). *Berardiopsis* is known from the middle Pliocene, while the other 15 genera from the Miocene. As *Cetorhynchus* and *Paleoziphius* are based only upon lower jaws, comparison with the present two specimens is not possible. These two genera are probably related to *Incacetus*, *Notocetus* and *Squalodelphis*, which are known from skulls possessing an non-reduced dentition (MEAD, 1975). The present two specimens show

Table 1. Measurements (mm) of rostral fragments of the two fossil beaked whales, *Mesoplodon tumidirostris* sp. nov. collected from the sea bottom in the central North Pacific.

No.	Measurements	Holotype (NSM-PV 19732)	Paratype (NSM-PV 19733)
1	Maximum length of the specimen	559	405
2	Tip of rostrum to end of vomer	550	—
3	Tip of rostrum to the posterior end of premaxillary foramen (left)	488	—
4	Tip of rostrum to the posterior end of premaxillary foramen (right)	490	—
5	Tip of rostrum to the posterior end of maxillary foramen (left & right)	488	—
6	Tip of rostrum to the anterior end of maxilla (left)	5.3	—
7	Length of rostrum	444	—
8	Width of rostrum at 1/4 rostrum from the tip	31.5	—
9	Height of rostrum at 1/4 rostum from the tip	38.1	—
10	Width of rostrum at midlength	38.8	—
11	Height of rostrum at midlength	47.5	—
12	Width of rostrum at 3/4 rostrum from the tip	51.3	—
13	Height of rostrum at 3/4 rostrum from the tip	60.9	—
14	Width of rostrum at the anterior end of mesorostral ossification	54.1	69.6
15	Width of rostrum at base	105	106
16	Tip of rostrum to the anterior end of mesorostral ossification	338	—
17	Length of mesorostral ossification	144	168
18	Greatest width of mesorostral ossification	48.2	39.7
19	Greatest height of mesorostral ossification	51.0	49.0
20	Lenght of premaxillary foramen (left)	10.0	5.2
21	Width of premaxillary foramen (left)	7.2	5.4
22	Length of maxillary foramen (left)	23.1	33.7
23	Width of maxillary foramen (left)	7.0	11.0
24	Distance of premaxillary foramina	22.8	25.7
25	Distance of maxillary foramina	73.8	90.6
26	Tip of rostrum to the anterior end pterygoid (left)	39.7	—
27	Tip of rostrum to the posterior end of pterygoid (left)	47.8	—

reduced dentition, so that they are not related to those three genera. As *Choneziphius*, *Eboroziphius*, *Pelycorhamphus* and *Ziphirostrum* show premaxillary basing, they are not related to the present two specimens which lack premaxillary basing. *Belemnoziphius* and *Proroziphius* have relatively flat premaxillae and show various modes of mesorostral ossification. MEAD (1975) considered that *Mesoplodon* was very likely derived from a group of *Belemnoziphius* and *Proroziphius*.

PILLERI and PILLERI (1982) reported on 10 fossil species (*M. tenuirostris*, *M. farnesinae*, *M. bononiensis*, *M. longirostris*, *M. gibbus*, *M. medilineatus*, *M. senensis*, *M. lawley*, *M. danconae* and *M. menegbini*) of the genus *Mesoplodon* deposited in the Giovanni Capellini Museum of the Bologna University, Italy. WHITMORE *et al.* (1986) reported *M. longirostris* dredged from a depth of 650 m on the Miami Terrace. None of these species show a large mesorostral ossification. We conclude that the present two North Pacific specimens appear to be related to *Mesoplodon*. The morphological difference between the above two specimens might be due to either a specific or sexual difference (Figs. 1–8) (Table 1). It is well known that living beaked whales have wide variation in cranial shape (FRASER, 1942; MITCHELL & HOUCK, 1967; OMURA, 1972). We consider, therefore, that both specimens are probably conspecific, and that their differences are commensurate with what is known about sexual difference in living beaked whales. The paratype specimen has a larger rostral width at the anterior part of mesorostral ossification as compared with the holotype and is, therefore, probably an adult male. The holotype specimen may be an adult female. This should be reconsidered by systematic comparison using more samples.

Acknowledgements

Our sincere thanks are due to Messrs. Yūzo MIKUNI and Misao IWABUCHI for their kind permission to our scientific examination on the fossil specimens and to donate them to the National Science Museum, Tokyo. We thank the former Director Shiro SAWA and Mr. Jun-ichi YAMASHIRO of the Kushiro City Museum, Hokkaido, who sent us the fossil materials for examination and helped us to obtain background information from Messers Y. MIKUNI and M. IWABUCHI. Particular thanks are due to Director Alan N. BAKER of the Te Papa Tongarewa Museum, New Zealand and Dr. Shun-ichi UÉNO of the National Science Museum, Tokyo, for their criticism of the manuscript and useful suggestion. Dr. Yukimitu TOMIDA of the National Science Museum, Tokyo, permitted us to deposit these two specimens in the Division of Paleontology of the museum and supported us to make their casts. Mr. Toshiaki KURAMOCHI of Tokyo University of Agriculture and Technology kindly helped us in taking the photographs of the specimens.

References

FRASER, F. C., 1942. The mesorostral ossification of *Ziphius cavirostris*. *Proc. zool. Soc. London*, **1942**: 21–29.

IUCN, 1988. Dolphins, Porpoises, and Whales. 30 pp. IUCN Gland, Switzerland.

KELLOGG, R., 1928. The history of whales-their adaptation to life in the water. *Quart. Rev. Biol.*, **3** (1): 29–76.

MEAD, J. G., 1975. A fossil beaked whale (Cetacea: Ziphiidae) from the Miocene of Kenya. *J. Paleont.*, **49** (4): 745–751.

———, 1989. Beaked whales of the genus *Mesoplodon*. *In* RIDGWAY, S. H., & R. HARRISON (eds.), *Handbook of Marine Mammals*, pp. 349–430. Academic Press, San Diego.

MITCHELL, E., & W. J. HOUCK, 1967. Cuvier's Beaked Whale (*Ziphius cavirostris*) stranded in northern California. *J. Fish. Res. Bd. Canada*, **24** (12): 2503–2513.

MIYAZAKI, N., I. NAKAMURA, S. TANABE & R. TATSUKAWA, 1987. A stranding *Mesoplodon stejnegeri* in the Maizuru Bay, Sea of Japan. *Sci. Rep. Whales Res. Inst.*, **38**: 91–105.

MOORE, J. C., 1963. Recognizing certain species of beaked whales of the Pacific Ocean. *Am. Midl. Natur.*, **70**: 396–428.

NAKAMURA, K., 1989. Volcano and Plate Techtonics. 157–184. Tokyo University Press. (In Japanese.)

OMURA, H., 1972. An osteological study of the Cuvier's Beaked whale, *Ziphius cavirostris*, in the Northwest Pacific. *Sci. Rept. Whales Res. Inst., Tokyo*, **24**: 1–34.

PILLERI, G., & O. PILLERI, 1982. Catalogue of the fossil odontocetes (Cetacea) in the Bologna Giovanni Capellini museum of palaeontology with description of a new species of Hoplocetus (Physeteridae). *Mem. Scienze Geol.*, **35**: 293–317.

REYES, J. C., J. G. MEAD & K. V. WAEREBEEK, 1991. A new species of beaked whale *Mesoplodon peruvianus* sp. n. (Cetacea: Ziphiidae) from Peru. *Marine Mamm. Sci.*, **7** (1): 1–24.

WHITMORE, Jr., F. C., G. V. MOREJOHN & H. T. MULINS, 1986. Fossil beaked whales-*Mesoplodon longirostris* dredged from the ocean bottom. *Nat. Geogr. Res.*, **2** (1): 47–56.